LAYERED POLYMER FIBER INSULATION AND METHOD OF MAKING THEREOF

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Technical Field and Industrial Applicability of the Invention

The present invention relates generally to a multilayer, wet processed, polymer-based mats having bicomponent and polymer staple fibers, where the layers are bonded together using heat and pressure. This acoustical and thermal liner/insulator may be utilized to insulate an environment such as a passenger compartment of a vehicle from the heat and sound generated by mechanical components of that vehicle during its operation. Other uses include application in insulating appliances such as dishwashers and clothes dryers and providing sound and thermal insulation for furnaces, air conditioning units and ductwork in buildings including homes, offices and industrial structures.

Background of the Invention

Acoustical insulation is well known in the art. Acoustical insulation typically relies upon both sound absorption, i.e. the ability to absorb incident sound waves, and transmission loss, i.e. the ability to reflect incident sound waves, in order to provide sound attenuation. One of the more prevalent uses of such insulation is in the motorized vehicle field where engine compartments, fire walls, fender wells, doors, floor pans and

other components of the passenger compartment shell are commonly acoustically insulated to reduce engine and road noise for the benefit and comfort of passengers. Acoustical insulation is also prevalent in appliances such as dishwashers and heating and air conditioning units.

U.S. 6,008,149 discloses a moldable nonwoven fibrous composite article including at least two functional layers, which are made of the same nonwoven thermoformable polymeric chemical substance or material. The composite articles are molded from separate rolls or sheets of variable compression and formable fabric layers.

Each of U.S. Patent Nos. 6,156,682 and 6,364,976 discloses a laminated structure having a core of polymeric fibers, a thermosetting resin impregnated into the core, and individual chopped fibers randomly applied to opposite sides of the core layer. The preferred method of bonding the fibers together is by a bicomponent fiber, in which an outer layer of fibers is constituted by a low melt temperature polymer, and an inner core layer of fibers which constitutes a polymer with a relatively higher melt temperature.

U.S. 4,780,359 discloses a nonwoven textile panel constructed of three layers of nonwoven textile fibers of polyphenylene sulfide fibers and Nomex® brand aramid fibers that have been carded, cross-lapped, needled-punched and thermally bonded by heating the panel to the temperature softening point of the polyphenylene sulfide fibers.

U.S. 5,501,898 discloses a support part for automobile roof linings. The part may have from one to three layers consisting exclusively of polyester fibers. The part contains no binder resin, connective fibers or glass fibers. All of the layers are pressed and compacted into the intended shaped by the action of pressure and heat.

U.S. 5,709,925 discloses a multi-layered laminated body used as an interior trim panel for an automobile. The panel includes a three-layer substrate which includes a layer of natural fiber filler material embedded in a thermoplastic matrix and two cover layers comprising natural fibers, glass fibers or polyester fibers in a thermoplastic matrix material. In additional to the substrate, the panel further includes a foam intermediate layer and a decorative surface layer. The panels are produced by hot-laminating the individual layers of the substrate together and then laminating and molding the decorative surface layer onto the substrate.

In the past, it has been common practice of produce cotton shoddy or polymer-based insulation blanket by methods such as carding, garneting or using an air laid system. This is a need for an improved insulation providing enhanced acoustical properties. Further there is a need for a polymer-based that is produced from layers of wet process mat to a thickness and fiber formulation that yields a unique combination of properties that cannot be obtained by single, uniformly produced materials. There is also a need for a product that can be manufactured at a lower cost.

Summary of the Invention

In accordance with the purposes of the present invention as described herein, an improved acoustical, compressible, polymer fiber liner/insulator is provided. The blanket is made of multipies layers of wet process polymer based mats formed of bicomponent fiber and polymer staple fibers bonded together using heat and pressure. The liner/insulator is typically used in automotive applications such as automobile doors or automobile passenger compartments to insulate the compartments from the heat and sound. The thermal/acoustical liner may also be used in appliances such as

dishwashers, heating and air conditioning units, marine applications and commercial interiors.

It is an object of the present invention to provide a liner/insulator having multiple layers of wet process polymer based mats bonded together to yield a desired thickness with unique acoustical properties.

It is a further objection of the present invention to provide a liner/insulator having multiple layers of wet process polymer based mats which are of varying thickness and varying fiber formulation.

It is a further objection of the present invention to provide a liner/insulator, which is made by a low cost manufacturing process that provides a uniformity of fiber distribution in the final product.

It is a further objection of the present invention to provide a polymer based liner/insulator product comprised of built up layers of wet process mat to a thickness and fiber formulation that yields a unique combination of properties that cannot be obtained by single, uniformly produced materials.

Still other objects of the present invention will become apparent to those skilled in this art from the following description wherein there is shown and described preferred embodiments of this invention, simply by way of illustration of several of the modes best suited to carry out the invention. As it will be realized, the invention is capable of other different embodiments and its several details are capable of modification in various, obvious aspects all without departing from the invention. Accordingly, the drawings and descriptions will be regarded as illustrative in nature and not as restrictive.

Brief Description of the Drawings

The accompanying drawings incorporated in and forming a part of the specification, illustrates several aspects of the present invention and

together with the description serves to explain the principles of the invention. In the drawings:

Figure 1 is a cross-sectional view of the liner/insulator of the present invention.

Figure 2 illustrates a wet-processing line for forming the liner/insulator of Figure 1.

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawing.

Detailed Description And Preferred Embodiments of the Invention

Reference is now made to Figure 1, which illustrates the liner/insulator designated by reference numeral 1. The polymer fiber blanket 1 is constructed of a plurality of layers 2, 4, and 6. Layers 2, 4 and 6 are individual layers of wet processed mat.

The wet process which is used to make the individual layers of the liner/insulator is described in commonly assigned U.S. Patent Application Serial No. 10/636,078, filed August 7, 2003, which is herein incorporated by reference in its entirety. Fig. 3 illustrates a typical processing line 50. A combination of polymer staple fibers 22 and the bicomponent fibers 24 are added to a whitewater chemical dispersion 52 within a mixing tank 56 to form thick whitewater slurry 54 at consistency levels of approximately 0.2 to 1 percent. The thick slurry 54 formed is maintained under agitation in a single tank 56 or series of tanks.

The whitewater chemical dispersion 52 is used to obtain reasonable filamentation of the polymer staple fibers 22 and the bicomponent fibers 24 through steric, thermodynamic, and charge colloidal interactions. The

preferred whitewater dispersion 52 includes a viscosity modifier, a defoamer and a surfactant.

The viscosity modifiers used in the whitewater dispersion 52 are commonly used in nonwoven-type applications. One preferred class of viscosity modifiers is a polyacrylamide viscosity modifier such as Nalco 7768, Magnifloc 1886A, and HyChem AE 874. Another preferred viscosity modifier is a hydroxyethylcellulose, such as Natrosol 250HHBR. However, other possible viscosity modifiers or flocculants that may be used include high molecular weight, water-soluble polymers that are well known to those of ordinary skill in the art.

The surfactants, or cationic dispersants, used in the whitewater dispersion aid in the wetting of the polymer staple fibers and the bicomponent fiber so that bundles of the fibers will disperse into individual filaments. One class of surfactants utilized are ethoxylated alkylamine dispersants such as Schercopol DS-140, Nalco 8493, or Rhodameen VP532. However, other dispersants may be used as well, including fatty acid amine oxides and polyethoxylated derivatives of amide condensation of fatty acid products. Also, preferred defoamers utilized in the whitewater dispersion 52 include Nalco PP04-3840 and GEO FM LTX.

The thick slurry 54 is then delivered through a control valve 58 and combined with a whitewater stream 76 from a silo 78 to form a lower consistency slurry 80 in the former 82. The ratio of thick slurry 54 to the silo stream 78 in the lower consistency slurry 80 will typically be in the range of 1:10 and 1:40.

The former 82, or headbox, functions to equally distribute and randomly align the fibers 22,24 onto a moving woven fabric, or forming wire 96, therein forming the filament network 14. Formers 82 that can accommodate the initial fiber formation include Fourdrinier machines,

Stevens Former, Roto Former, Inver Former, cylinder, and VertiFormer machines. These formers offer several control mechanisms to control fiber orientation within the network 14 such as drop leg and various pond regulator/wall adjustments.

Deposited fibers forming the network 14 are partially dried over one or more suction boxes 94. The dewatered network 14 is then run through a drying oven 97 at a temperature sufficient to remove any excess water and sufficient to melt the sheath of the bicomponent fibers 24, typically about 130 to 180 degrees Celsius. Upon removal from the oven 97, the sheath material cools and adheres to polymer staple fibers 22, therein forming one of the insulating layers.

The wet process is preferred over various dry-laid processes because the wet process provides an insulating layer with a more consistent weight per unit area. The wet process also provides more intimate mixing of the fiber blends and more random fiber orientation. Compared with dry-laid processes, the wet process is capable of high production rates, thus providing a less costly insulating layer.

The layers 2, 4 and 6 are preferably made of thermoplastic polymer fibers including thermoplastic polymer bicomponent fibers and thermoplastic polymer staple fibers. The thermoplastic staple fibers and bicomponent fibers may be selected from a group of materials including but not limited to polyester, polyethylene, polypropylene, nylon, rayon, acetate, natural fibers (i.e., kenaf or hemp), polyethylene terephthalate and any mixtures and/or copolymers thereof. Further examples of fibers used can be found in commonly assigned U.S. Patent Application No. 10/636,078, filed August 7, 2003.

Preferably, the mat is made of 100% polymer fibers (polymer bicomponent fibers and polymer staple fibers). The bicomponent fibers

bond the fibers together within each individual layer of the mat. Heat and pressure is then applied to the mat and the multiple layers 2, 4 and 6 are bonded together. Conventional flow-through ovens used in the art are used to heat and apply pressure to the layers 2, 4 and 6. Alternatively, a surface-treating device may be used to bond the layers together such as that described in commonly assigned U.S. Patent Application Serial No. 10/609,947, filed June 30, 2003 herein incorporated by reference in its entirety. The preferred temperature used to bond the layers 2, 4, 6 is between about 250° to about 400° F. The amount and type of bicomponent fibers selected for the fiber formulation determines the strength of the bond formed between the multiple layers.

In a preferred embodiment, the layers 2, 4 and 6 are typically between about 0.05 to about 0.30 inches thick. Preferably, the thickness of the final product is between about 0.125 and about 1.5 inches thick. The layers 2, 4, 6 can have the same thickness, weight, fiber formulation or the layers can have two or more different combinations of fiber formulations, thickness and weight.

By utilizing different combinations of fiber formulations, weight and thickness, in the individual layers, the final product can be "tuned" to meet acoustical and thermal requirements. For example, base layer 6 may be formulated to have a high heat resistance and/or have hydrophilic properties. To provide high heat resistance, fibers such as high-melting bicomponent fibers, semi-crystalline fibers, thermoset polymer fibers or fibers coated with a heat resistant resin may be used. To provide hydrophilic properties, hollow or shaped polymer fibers may be utilized. Further, the fibers may be coated with a water-swellable coating.

Another layer, such a layer 4, may be composed of a fiber formulation that provides a barrier to moisture (hydrophobic fibers).

Examples of such fibers in layer 4 include, but are not limited to, polyolefins, polyacetate and fibers having small pores or micro-denier fibers may be utilized. Layer 2 may be composed of a fiber formulation that absorbs sound. Examples of sound absorbing fibers include, but are not limited to, natural fibers such as hemp and kenaf.

In another embodiment of the present invention, it may be advantageous to use one or more layers of the wet processed mat, as described above, in conjunction with a layer of polymer-based fibrous mat insulation.

Optionally, the liner/insulator may include a facing, on one or both sides, to improve strength and/or surface appearance. Other embodiments including facings and fiber combinations that may be used with the present invention are discussed in U.S. patent 6,669,265, which is incorporated herein by reference in its entirety.

A facing may be applied to the liner/insulator by heating one side of the liner/insulator, while the other side remains relatively cool. A pressure is then applied for sufficient time to allow the polymer binding fiber to soften near the hot surface but not near the cold surface. When this occurs under compression, the hot side is reshaped into a higher density surface layer. The cool side of the polymer binding fiber does not soften and, therefore, when the pressure is removed, the base zone retains most of its original thickness and density characteristics. The intermediate zone undergoes only moderate densification. This technique may be performed in a standard molding press where one platen runs hot and the other runs cool. This is followed by the printing of a selected face of the facing layer with desired graphics, patterns, designs or indicia. This process is described in detail in U.S. Patent Applications 10/421,565, filed April 23, 2002 and

10/749,087, filed December 30, 2003, which are herein incorporated by reference in their entirety.

The embodiments were chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.